## VIII. *On the matrivorous habit of the species of* Heterogynis, Rmbr. By T. A. Chapman, M.D., F.Z.S.

[Read February 1st, 1905.]

In presenting these notes in extension of my previous papers on *Heterogynis*, Rmbr., the regret, I must acknowledge, in having to correct an error I had fallen into but slightly modifies the satisfaction I have in having at length made certain observations, which I ought no doubt to have made before, and in fact narrowly escaped making. The satisfaction results not so much from the somewhat remarkable nature of the observations themselves, as from the circumstance that they appear to explain the object to be attained by, and therefore the forces in action that evolved, the very anomalous specialization of the female imago in this genus, and relieves us from having to regard them as isolated and inexplicable phenomena.

In my paper on *H. paradoxa* in the Transactions of the Society, 1902, pp. 717–718, I said that the young larvæ of that species "hibernate by spinning a small cocoon in some crevice of the food-plant or elsewhere. *H. paradoxa* does this, I find, in the second instar; Mr. Fletcher found *H. penella* did so in the third. Whether there is here a real specific distinction I cannot say, or whether there may be an error of observation on my part, or Mr. Fletcher's. The newly-hatched larva of *H. penella* is certainly much smaller than that of *H. paradoxa*." Again, p. 726, I wrote, "The newly-hatched larvæ present very important differences that have perhaps more specific value than any others." I then proceed to describe certain differences in the possession of stellate hairs by *paradoxa* which are not to be found in *H. penella* until the second instar.

This year I met with *H. paradoxa* at La Granja; I was too late for larvæ or moths, but found cocoons, from some of which the larvæ had already hatched, from others of which they emerged after I took them. Perchance the want of the more interesting stages made me attend more closely to the material I had. The result of my observa-

tions is that the passages I have quoted above from my previous paper on the species, are quite correct, if, by "hatching," one means the emergence of the young larvæ from the pupa-case and cocoon of their mother. But as the true meaning of the word is emergence from the egg they are all wrong. *Hinc illæ lachrymæ*, though I rejoice more over the correction than I weep over the error.

The actual facts are that in all the species the newly-

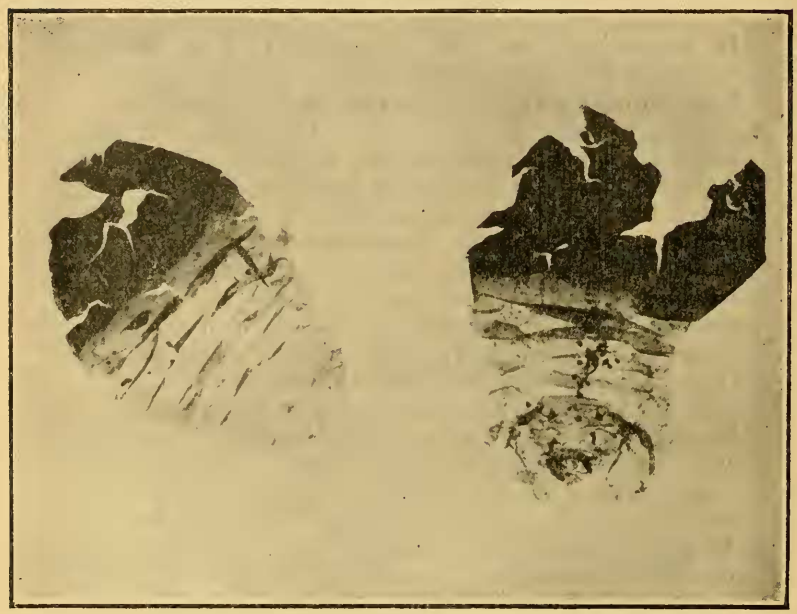

Fig. 1.

hatched larvæ are very similar; in all, their first pious duty is to eat the remains of their mother.

Having done this, *H. pcnella* and *H. canalensis* perforate the maternal pupa-case with various openings and make their escape. An examination of the empty pupa-case they have left shows it quite clean and containing only a very few threads of silk entangling a small but varying number of small greyish pellets, which I take to be urates or some similar effete product of the dead mother. In *H. paradoxa*, for some reason, the procedure is different, probably because the mother is much larger than in the

other species, and the difference in size is largely expressed not in the size or number of her eggs, but in the mass of eatable materials she represents after her decease. At any rate the young larvæ get larger than do those of the other species, and undergo their first moult before penetrating the pupa-case and cocoon and venturing to appear at large.

A pupa-case of *H. paradoxa* ♀, from which the young

Fig. 2.

larvæ have emerged, presents a dirty and muddled aspect due to the presence of a good deal of spinning by the young larvæ, amongst which the skins they cast at their first moult are entangled.

A very interesting point is that there is no trace of larval frass present in either species. This one can more easily understand perhaps in the case of *H. penella*, where the total amount of maternal tissue is small, and each larva gets but little, as evidenced by their small size on emerging from the parent cocoon. But in the case of *H. paradoxa* the amount must be considerable, as the larvæ grow very

appreciably, in fact about double their size, besides going through a whole instar and making a moult.

I am afraid that in my previous observations, made in the first place hurriedly in the field, and not afterwards properly verified, I mistook the heads of the cast skins for larval frass, and assumed some such amount of frass to be what one would reasonably expect after their first meal of the maternal tissues. In *H. paradoxa* one finds, however, nothing but some threads, the cast larval skins (skins as well as heads), and the pellets of urates, which from their small number and comparatively large size are obviously maternal and not larval *débris*. The young larvæ therefore go through a whole instar, more than double their size, undergo a moult, and then perforate the pupa skin, and make their way through the cocoon without ejecting any frass or effete material. It seems to follow that the maternal remains must consist almost entirely of completely assimilable materials. As the larvæ on facing the world have to begin life in many cases by making a long journey to find their food-plant, a meal before starting is an obvious advantage, but this does not explain the curious details of the process, or why it should differ in the several species.

I should note that I have examined just now pupæ of *paradoxa* and *canalensis*, but have no adequate specimen of *penella* by me. With regard to it, therefore, I merely assume from my previous observations of it that it agrees with *canalensis*.

It results that at corresponding instars the larvæ of the several species are very much alike, it also follows that the discrepancy between Mr. Fletcher's observations as to the hibernating instar of *H. penella* and mine of *H. paradoxa* does not exist, though it is my fault that there appeared to be one.

The distinction I drew between the first instar larvæ of *H. penella* and *H. paradoxa* does not exist as a structural difference at all; nevertheless there is a difference between them in habits and instincts, which is probably of quite as great importance.

The only other matter I observed this year at La Granja as regards *H. paradoxa* was that it had two widely-separated habitats, one at about 5200 ft. elevation, where its food-plant was *Adenocarpus hispanica*, the other at about 7000 ft. on *Cytisus purgans*; the opportunity was wanting

to determine whether there was any varietal distinction between the two races, but this is very probable, as the intermediate country and elevations were without any "broom" capable of nourishing the species, so that the two colonies were probably segregated with considerable strictness.

The extreme development of the matrivorous habit in *H. paradoxa*, and its obviously great importance in the economy of the species, afford an explanation of the remarkably aberrant habits and structure of the female imago, and give us some hints as to the probable steps by which they were evolved.

Though the latter are more or less hypothetical, and therefore less certain than the former, we may take them first, as they are so in point of time.

We may safely assume that the first steps in the process of evolution were similar to those that obviously obtained in *Psyche* and *Orgyia*. Firstly, apterousness of the ♀ consequent on laying the eggs, on or in the cocoon or close by. Then eggs laid in the pupa-case. And somewhere at this point the dominating conditions would probably be those which I imagined still to obtain, as no doubt subsidiarily they do, when I discussed this matter in connection with *H. penella* (Ent. Trans., 1898, p. 46), viz. protection of the eggs from enemies and from desiccation by the mother dying in and blocking the open end of the pupa-case. At this time the moth probably still retained some legs and some scales or hairs. Both Psychids and Orgyias still retain some hairs, so far as I know, in all cases.

The delicate nature of the eggs (as in the allied Anthroceras) would make protection against drought a strong selective agency, and there would now come in the matrivorous instincts of the larvæ. These no doubt would originate accidentally in the necessities of the larvæ finding a way of escape from the pupa-case, leading some of them to do so by eating into, or at least nibbling the dead body of the ♀. So soon as matrivoracity became definitely an instinct then several forces would come into action. As these would be the same that now keep the arrangements in their present perfection we may better consider them in connection with the explanation they afford of existing facts. The very complete closure of the pupa-case, so that it looks as if it had never been opened, and no moth ever emerged from it, becomes very important when we regard

the body of the moth no longer as a second line of defence, but as a store of food to be kept from enemies gross or bacterial, from drying up, and from other dangers. The precautions for the moth getting safely back into the pupa-case, apparently rather a hopeless matter considering its maggot-like structure, become more obviously matters of necessity, leading up to the organic connection the moth has with the pupa-case at the sites of the atrophied legs. The brief time the moth remains out of the pupa-case, less probably sometimes than five minutes, is not only important as minimizing the period of exposure to enemies, but also as a period of deterioration of the moth as a food material.

We next come to the extraordinary structure (or want of structure) of the moth itself. Everything aims at the whole available forces and materials possessed by the larva when it spins its cocoon being devoted to egg formation on one hand and larval food on the other, and further that the last object hardly takes a second place. If we compare the female *Heterogynis* with those females of the Psychids in which the structures have most degenerated, we find that in the Psychids everything has given way to egg development. The protection of the eggs is achieved chiefly by mixing them with the hairs from the maternal surface, and the female drops out of the case after she has laid her eggs as a mere scrap of chitin, with considerable masses of urate sand some little fluid. There is, in fact, nothing whatever edible. In *Heterogynis* no hairs are used to protect the eggs, and not only is the ♀ devoid of hairs and scales, but the cuticle is a simple membrane without traces of the bases of hairs or scales, without any skin points or other structures, and if I said actually without chitin, I think I should commit no large error demonstrable in a chemical balance. In the next place, the urates are very small in amount. The quantity which most insects void on emerging from the pupa is very considerable, partly left in the pupa-case, partly voided after the wings are expanded; it is usually in solid particles suspended in fluid; there is usually some excess fluid to be got rid of after the wings are expanded. Why are these urates less in the case of *Heterogynis*? If I am asked are they really so, I must admit that I am not prepared to meet the question, as having weighed the material in question. But the thing seems to me to be

so obvious, comparing the few pellets remaining from *Heterogynis*, with the deposits usual in most moths of similar size, that the matter is self-evident. The urates represent the amount of tissue waste that has taken place. Now in *Heterogynis* this tissue waste is that involved in the muscular exertion of spinning the cocoon, in casting the larva skin, and in the emergence and retreat of the moth, and in laying her eggs. The whole process of histolysis and development by which the larval structures are absorbed, and the imaginal (wings, legs, hairs, scales, antennæ, etc.) are built up from their embryonal condition is completely saved; this process must in ordinary Lepidoptera require a good deal of expenditure of tissue material. In *Heterogynis* not only are no imaginal structures developed, but the larval skin muscles and the larval colouring remain unchanged. I have already noted the skin to be devoid of the usual skin points, but there are in fact no hard parts whatever, no head plate, no prothoracic plate, no appendages, no solid parts to the ovipositor, etc. Everything is eatable, and all is eaten; I do not think we can find in the imaginal composition any explanation of why the larvæ void no excreta during a whole instar, and until, during the second instar, they have made their escape from the parental cocoon.

This is probably a matter of hygiene, by which the presence of such excreta would be most undesirable amongst the crowded larvæ, especially if their emergence were delayed by any climatic or other causes. The case of such larvæ as those of *Cnethocampa*, whose nests are loaded with frass, are hardly parallel, since these nests are very roomy, and the portion into which the larvæ crowd are more or less free from frass, whilst in the *Heterogynis* pupa-case the larvæ are solidly wedged together with no spare space and very few threads of silk. That there shall be no frass, however, that the larvæ shall not require to void anything, it is no doubt necessary that the pabulum shall be of a most concentrated and digestible nature.

Summarizing the facts now advanced, there is first the correction of the error as to first stage of *H. paradoxa*, due to the recognition of the circumstance that it does not emerge from the maternal pupa-case and cocoon till it has moulted into the second instar. Secondly, the importance in the economy of the genus, and especially in *H. paradoxa*, of the matrivorous habit, all the details

connected with which are elaborated to a degree, and of which the remarkable structure of the female and her way of life, are items which it very largely explains. I cannot call to mind any other Lepidopteron with such a matrivorous habit.

## Description of Figures.

Pupa-cases of *H. canalensis* (fig. 1) and *H. paradoxa* (fig. 2) longitudinally divided and placed on slides—all contents preserved. Photographs by A. E. Tonge, Esq. The amplification is four diameters.

The *H. canalensis* pupa has no contents, but a few grey pellets of maternal urates.

The *H. parodoxa* has similar pellets, but also contains larval skins, of which the heads are very conspicuous, cast on their first moult by the young larvæ. There is no larval frass. There is in neither case any trace of the mother except the pellets of urates.

The more solid abdominal ends of the cases are split irregularly.